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Survey of Data Mining Tools and Techniques for Customer Relationship Management (CRM)

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Abstract— The domain of Customer Relationship Management (CRM) has been gaining significance in various business management processes. CRM includes all the series of action that an organization uses to create and establish good relationships with the customers. Deploying technologies and tools of data mining in CRM can introduce a new area where companies can obtain competitive advantage. Using CRM, a company can make its process to launch better services at a minimized price. By the use of data mining tools & techniques, companies can obtain invisible data of customers from relatively huge databases. Hence, corporations can determine the worth of customers and estimate their future actions and needs. Data mining tools can provide solutions to business problems which were complex to trail down before. So, it is feasible to improve CRM effectiveness and have productive and quick answers to customer needs, by combining CRM and data mining techniques. In this study I explore some major concepts of CRM and data mining. Also I present an idea to employ data mining techniques in CRM. This analysis shows by that applying data mining tools & techniques in CRM that could improve CRM's effectiveness and give us a better forecasting ability to companies and industries to obtain a financial advantage.

Keywords— Data Mining, Data Mining Tools, Customer Retention, Customer Relationship Management (CRM), CRM Applications.

I. INTRODUCTION

The concept of mass production and enhanced marketing strategies first created during the [1] Industrial Revolution are being superseded by new beliefs in which customer relationships is of greatest significance.

A. CRM

Customer satisfaction ensures competitive advantage and good earnings for businesses in the long run. Customer bases created over a span of time has been of great aid in expanding the extend of a business's product or service. However, the current rise in the operating costs of businesses is compelling companies to evolve their loyalty programs among its present customers while trying to lure new ones. CRM can be defined as the process of forecasting customer behavior and selecting actions to affect their behavior for the benefit of the company. [2]

The goal of CRM applications is to attract, retain and manage an organization’s beneficial customers.

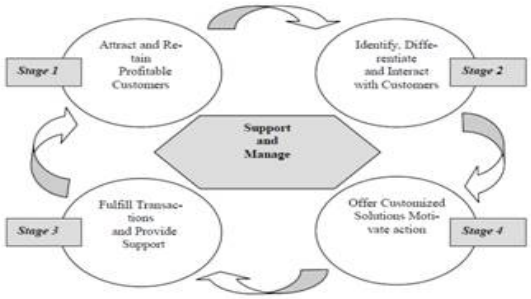

Fig No.1: Process model For CRM [11]

B. Data Mining

Data mining has been gaining huge focus in the information industry in recent years. Due to the ease of use of huge amounts of information and the fast approaching need for converting such data into useful knowledge and information. The data and knowledge gathered can be used for various applications varying from customer retention, market analysis and fraud detection etc.

Data mining is the process of extracting adequate information from large quantities of data. DM is the technique of finding new interesting patterns and relationships concealed in huge amounts of data. Holshemier and Siebes (1994).

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C. Applications of Data Mining Tool in CRM

Some of the data mining applications are given below [10]

1) *Customer Retention:* Its program begins with modelling those customers to find out discrete segments in their bases by means of supplementary variables exceeding conventional analysis.

Warranties: Makers can predict the customer profile who can submit warranty claims.

2) *Manufacturing:* Manufacturers have begun to customize their products for customers enabling them to anticipate which features can be included to meet customer demands.
3) *Frequent flier incentives:* Airlines identify customers who can be given benefits to fly more.
4) *Telecommunication:* By distinguishing customer segments having similar patterns, companies.

Can develop attractive pricing and feature promotions.

5) *Sales and Customer Services:* When data is collected properly and supplied to frontline service professionals, customer service is considerably improved. If customer data is available on time, software can be used to automatically endorse their products and also help in resolving decision for stock.
6) *Database marketing:* Many retailers create customer profiles with some definite behaviour, like those who people who purchase designer labels clothing. This data can be used to target cost effective promotions.
7) *Fraud Detection:* Industries are aware that fraud detection is very important . There is a huge concern of dishonest employees and retailers continue to look for ways to minimize the number of dishonest cashiers. Many supermarkets have began using digitized CCTV's, together with Point of sale data mining to allow loss prevention managers to expose cashier stealing.
8) *Risk Management:* Data mining allows banks to find and reduce risks by helping them recognize what their customers intends to do. Supermarkets can focus on customers who are more likely to buy a certain product .
9) *Marketing:* Marketing depends greatly on correct information for executing retention programs, loyalty cards, targeted promotions, etc. By having the entire profile of the customer, promotions can be focused and targeted thereby dramatically increasing response rates and reduce campaign cost.

D. Data Mining Techniques for CRM

Data mining techniques involves discovery and learning. These techniques are helpful to achieve the objective of CRM by obtaining or observing hidden customer attributes and behaviours from big databases. Following are the some mining techniques [6]:

1) *Association Rule Learning:* It is a popular method for uncovering interesting relationship between items that exist with each other in a given record. This rules was established to find regularities between products in high quantities of transaction data recorded via point-of-sale (POS) systems .This type of data can be used for decision making regarding marketing activities like promotional pricing, Market basket analysis.
2) *Classification & Prediction:* Prediction and classification are two types of data analysis techniques that are used to extract important data classes and to forecast future trends. Classification focuses to plot a data item into one of numerous predefined certain classes (Mitra etal., 2002,Berson et al., 1999; Chen et al., 2003; Ahmed, 2004). Example, a classification model can be able to identify loan applicants in low, medium, or high credit risks categories [3].Prediction aims at building a model to predict future customer behaviours through record patterns. Data classification techniques include decision tree classifier, Bayesian classifier, rule-based classifiers, and support vector machines. Prediction technique includes linear regression, non-linear regression.
3) *Clustering:* Clustering enables to map data by similar type of records that are grouped together. Usually, clustering is performed to give the end user a high-level view of what is happening in the database. Clustering gives a birds-eye view of the business .
4) *Regression Analysis:* Regression analysis helps us to give a real-value prediction variable and analysing how the value of one dependent variable varies when one of their independent variables is altered, while the other independent variables remain same. Ex. Curve fitting, including forecasting.
5) *Visualization:* Visualization refers to the arrangement of data so that users can view complex patterns.(Shaw, 2001).

It is used together with other mining models to provide a clear understanding of the uncovered patterns or relationships.(Turbanetal.,2010).

According to Friedman (2008) the main aim of data visualization is to convey information effectively and clearly through graphical means. Ex. mind maps.

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6) *Sequence discovery:* Sequence discovery helps in finding patterns where one event leads to another event. It helps in predicting future trends thereby helping the organization.

Customer's lifetime is to understand customer's behaviour and include the following four basic steps[12]:

a) *Prospects:* people who are not customers yet but are in the market as a target customer.
b) *Responders:* people who display an interest towards a product .
c) *Active Customers:* prospects who are using the product or service currently.
d) *Former Customers*: they may be unacceptable customers who did not make bill payment or who sustained outrageous costs.

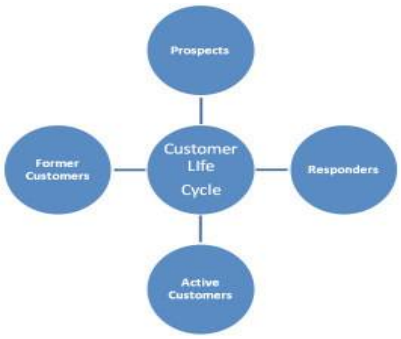

Fig. No. 2 : Customer life cycle[12]

E. CRM Dimensions

According to [4] and [5], CRM is made up of four dimensions:

1) *Customer Identification:* This phase involves closing on the people who are likely to be a customer or profitable to the company through analysis of customers' underlying characteristics. Identification includes target customer segmentation and customer analysis.
2) *Customer Attraction:* After customer identification, the organization concentrates all the energy and resources to attract the profitable customer through direct marketing.
3) *Customer Retention:* The best way to retain customers and restoring them is by increasing their satisfaction. It is the core of CRM. It includes complaints management and loyalty programs.
4) *Customer Development:* It aims to increase customer transaction size with the company. Its elements include market basket analysis and customer lifetime value analysis. The customer lifetime value is the total earnings expected to be achieved from the customer during his link with the organization .Market basket analysis increases customer transactions by revealing orders in the customers' purchase behavior.

II. INTEGRATION OF CRM AND DATA MINING TECHNIQUES

Each CRM dimension can be categorized further into various levels. Customer identification consist of customer analysis and customer segmentation; Customer Attraction focuses only on one task that is direct marketing. Customer Retention is split into many levels: Loyalty programs, 1:1 marketing and Complaints Management. Customer development consists of customer lifetime value, up/cross selling and market basket analysis. The function of CRM dimensions can be accomplished using more than one technique; although some techniques perform better than others. Table shows the techniques that are superior for each task. The table has been extracted from several previous researches such as: [4], [5], [6] and [7].

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S. No.	CRM	CRM Dimensions	Data Mining Techniques
1.	Customer Identification	Target Customer Analysis	Classification Clustering Visualization
		Customer Segmentation	Classification Clustering Regression
2.	Customer Attraction	Direct Marketing	Classification Clustering Regression
3.	Customer Retention	Loyalty Programs	Classification Clustering Regression Sequence Discovery
		1:1 Marketing	Classification Clustering Association
		Complaints Management	Clustering Sequence Discovery
4.	Customer Development	Customer Life Time Value	Classification Clustering Forecasting Regression
		Up/cross Selling	Sequence Discovery Association
		Market Basket Analysis	Sequence Discovery Association

Table No.1: CRM with Dimensions and DM techniques

III.SELECTION OF DATA MINING TOOLS FOR CRM

There are many data mining tools available in the market. Nisbet (2004) pointed out that there are no best tool as each tool has its strengths and weaknesses; each tool may be the best for particular needs in particular companies. Yet the most persistent data mining tools used for the CRM are SAS, SPSS, ORACLE and Insightful miner (2007). They give various features to its user that helps companies to achieve financial gain. These tools can be categorized in following categories[6].

a)application specific tools; b)general purpose tools ; c)integrated OLAP/ DM tools .

The general purpose tools have a sizable amount of the market and are not specific to the application. Examples include SAS Enterprise Miner, Unica Pattern Recognition Workbench , XLMiner, IBM Intelligent Miner, IBM SPSS Modeler, Oracle Darwin, Ghost Miner, CART & MARS,SGI Mineset, Angoss Knowledge Seeker, Rapid Miner, Weka etc.

Integrated OLAP/DM tools has an actual and convincing need for business and has a single multi-utility tool helping in decision making that gives management reporting, online analytical processing and data mining capacity . Examples in this group include: Cognos Scenario, Business Objects etc.

The application-specific tools are swiftly attaining speed. It provides many business solutions.Some tools of this group are: KD1 which emphasizes on retail, ESTARD Data Miner which emphasizes on insurance industry, Unica Detect, Unica Leaders, Unica Predictive Insight emphasizes on fraud detection etc.

Some limitations of applying Data mining tools in CRM are given below[8]:

A. *Data Privacy:* It can generate results which will violate customer privacy. This causes problems for firms dealing with the data mining tools.
B. *Legal Issues:* Many countries do not allow data to be combined from different sources and use it for various purposes from those for which they have been collected.
C. *Challenge of obtaining data for extensive interpretation:* Gathering of data is still a problem in many industries. Some methods are unwanted and expensive to use.
D. *Better utilization of outcome:* How to utilize the output in performing various task is critical and it involves huge effort.
E. *Cost of Tools:* The complexity of the tools elevates its price. Greater the attributes in the tool, more costly the tool becomes

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F. The table shown below gives brief features of some of the Data mining tools for effective CRM along with the help of [8] and [9].

S. No.	Tools	Application Area	Data mining Functions	Techniques
1.	**Kxen**	Embedded in an application	Association rules, clustering, classification, prediction	Decision trees, K-means, Binary classification and regression (linear), rule induction
2.	**SPSS Clementine**	To support customer behavior modeling	Association rules, classification, clustering, factory analysis, forecasting, prediction, sequence discovery	Apriori, BIRCH, CARMA, Decision trees(C5.0),K-means clustering, neural network, regression (linear, logistic) rule induction(C5.0)
3.	**Insightful Miner**	Support strategic marketing operations	Association rules, clustering, classification, prediction, sequential patterns, time series	Decision trees(modified CART), K-means, neural networks (back propagation), regression (linear)
4.	**XL -Miner**	In Financial operation based on spreadsheets	Association rules, classification, clustering, prediction, time series	Discriminant Analysis Logistic Regression with best subset selection Classification Trees Naive Bayes Classifier Neural Networks k-Nearest Neighbors
5.	**SAS Enterprise Miner**	Dm tools, Embedded in an application, to support management rules reporting	Association rules, classification, clustering, prediction, time series	Decision trees,K nearest neighbors, regression(linear, logistic),memory-based reasoning, neural networks
6.	**Statistica Data Miner**	DM tools, in the Databases, Support of direct mail operations.	Variable Filtering, Association Rules, Interactive Drill-Down Explorer, Cluster Analysis, General Classification	Regression, K- nearest neighbors technique, general neural n/w explorer, general classifier.
7.	**Weka**	Tools for educational purposes and research	data pre-processing, classification, regression, clustering, association rules, and visualization	Decision trees, K-means, Regression, K- nearest neighbors technique, Classification Trees Naive Bayes Classifier Neural Networks k-Nearest Neighbors
8.	**Rapid Miner**	Tools for research, education, training, rapid prototyping	Association Rules and Clustering	Decision Trees, Bayesian Learner, Rule Learner, Logistics Learner

Table No. 2: Data mining Tools survey.

IV. CASE STUDY ON LEADING TECHNOLOGY ORGANIZATION ORACLE

Oracle's Data mining model shows that Oracle has Oracle Advanced Analytics that suggests following Data Mining functions for Oracle database as a DBMS Package for CRM.

Choosing a suitable algorithm to use for a specific task can be a challenge. Expert analysts sometimes use one algorithm to deduce the most fruitful inputs then apply a different algorithm to predict a particular outcome based on that information. The Table below depicts which data mining functions are used in different application along with their methods.

Data Mining Functions	Applications For CRM	Methods
Classification	Classification of customers Rules/Transparency	Neural Networks Decision Trees
Forecast	Retaining customers	Decision Tree
Estimation	Reviewing websites	Cluster Analysis
Clustering	Spot irregularity Product Grouping	Nearest Neighbors Hierarchical k-Means
Deducing relations among variables	Data survey in Marketing Predict Stock market trends	Conclusion of Law Genetic Algorithm
Regression	Wide/ Narrow Data/ Text	Support Vector Machines
Association	Next best offer/Market Basket analysis	Apriori

Table No. 3 : DM techniques applications for CRM

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According to the research of Seyyed Pishvayi, utilization of Data mining for CRM in various domains is shown below with sales/marketing having the highest usage of data mining applications followed by customer retention, buyer behavior, cost utilization and Quality control also detection of fraud.

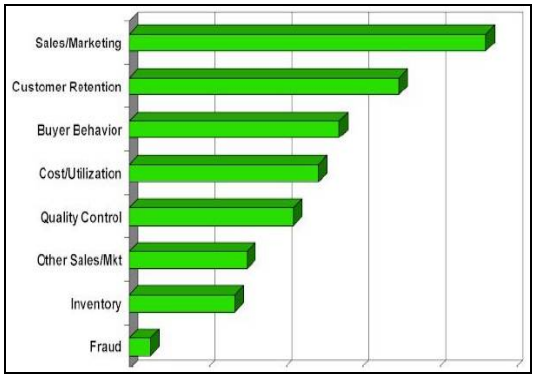

Fig. No. 3 : Usefulness of data mining with CRM for companies

A. Choosing an Algorithm by Task for CRM

A study of Data Mining Algorithms used by Microsoft SQL Server Data mining in CRM:

The algorithms provided in Microsoft SQL Server Data Mining are the well-researched and most popular methods of deriving patterns from data. To help in selecting an algorithm for work in a certain a task, the table below suggests the types of tasks for which each algorithm is conventionally used.

Applications	Algorithms
Forecasting distinct characteristics 1. Spot the customers in a potential buyers list as good or poor prospects. 2. Calculate the probability that a server will fail within the next 6 months. 3. Categorize patient outcomes and explore related factors.	Microsoft Decision Trees Algorithm Microsoft Naive Bayes Algorithm Microsoft Clustering Algorithm Microsoft Neural Network Algorithm
Forecasting steady characteristics 1. Forecast next year's sales. 2. Predict site visitors given past historical and seasonal trends. 3. Generate a risk score given demographics.	Microsoft Decision Trees Algorithm Microsoft Time Series Algorithm Microsoft Linear Regression Algorithm
Predicting a series 1. Perform series of click analysis of a company's Web site. 2. Analyze the factors leading to server failure. 3. Capture and analyze sequences of activities during outpatient visits, to formulate best practices around common activities.	Microsoft Sequence Clustering Algorithm
Identifying set of common items 1. Use market basket analysis to determine product placement. 2. Suggest additional products to a customer for purchase. 3. Analyze survey data from visitors to an event, to find which activities or booths were correlated, to plan future activities.	Microsoft Association Algorithm Microsoft Decision Trees Algorithm
Identifying set of similar items 1. Create risk profiles of patients based on characteristics such as demographics and behaviors. 2. Analyze users by browsing and buying patterns. 3. Identify servers that have similar usage characteristics.	Microsoft Clustering Algorithm Microsoft Sequence Clustering Algorithm

Table No. 4: Microsoft data mining Algorithms

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V. CONCLUSION

Data mining is of great significance as it helps in detecting credit card fraud, anticipating the interests of Web users, forecasting customer purchase behaviour, direct marketing etc. It helps companies in answering business problems by detecting patterns, correlations and associations which are hidden in the records stored in data bases. In choosing the right tool and technique, the company should deeply examine the tradeoffs between various tools. The more efficiently information is used about the customers to meet their demands, the more success an organization achieves. Through this paper we notice that there are various techniques and data mining tools in the market for CRM, but the right tools for the firms depend upon the procedure used in the firm and the objectives that the company needs to attain through the execution of the tools. Logically choosing the techniques and their right execution can prove advantageous for the organization and they would be capable to provide the right product to right group of customers through better offers which would steer them towards better customer relationship management. Hence Data Mining tools can help CRM with better interpretation of customer links and boost customer satisfaction and sharp gains for the firm.

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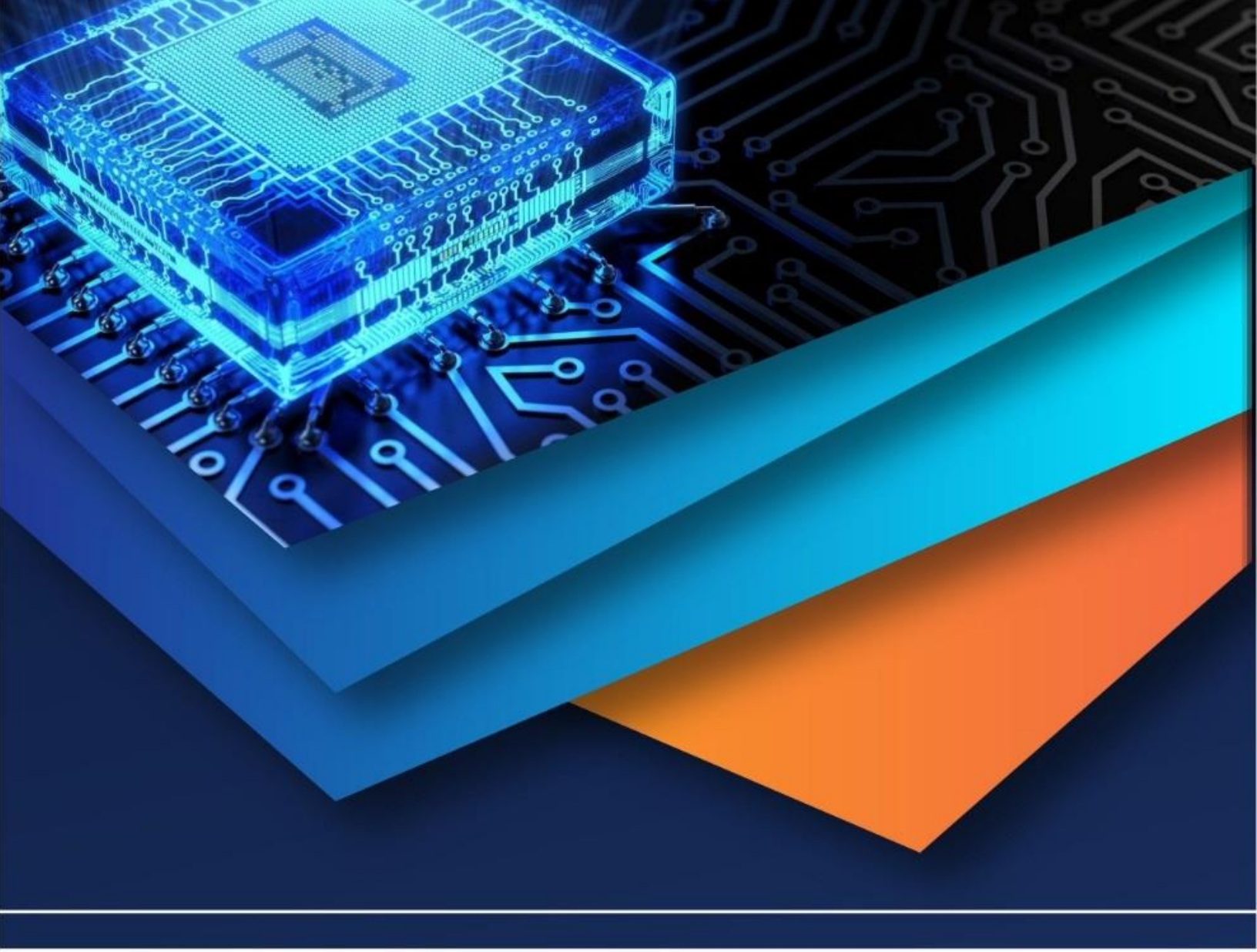

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